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ABSTRACT

In a study at California State University, Sacramento, the effects of color light and relaxation exercise therapy were investigated with 16 students (ages 23 to 48) with learning disabilities. Therapy consisted of either 20 sessions viewing color light through a Lumatron instrument or 20 sessions listening to relaxation exercise tapes. Diagnostic assessments included the Developmental Eye Movements test, a visual acuity test, a Peripheral Optotype Identification test, the Nelson-Denny Reading Test, and Wechsler Memory Scale subtests. T-test analyses revealed that only the color light group attained significant post-therapy test results. Statistical gains on posttests of the Nelson-Denny (Comprehension, Comprehension Reading Rate, and Vocabulary Reading Rate) and Weschler Memory Scale (Logical Memory) scores were documented. The study concluded that color light appears to hold promising therapy benefits for individuals with learning disabilities. (Contains 12 references.) (Author)

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Effects of Color Light and Relaxation Exercise Therapy on Adults with Learning Disabilities

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Services to Students with Disabilities

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Abstract

In a study conducted at California State University, Sacramento, the effects of color light and relaxation exercise therapy upon adults with learning disabilities were investigated. Therapy sessions for the 16 participants (ages 23-48) consisted of (a) twenty, 20-minute sessions viewing color light through a Lumatron instrument, or (b) twenty, 20-minute sessions listening to relaxation exercise tapes on a cassette player. Diagnostic assessments included the Developmental Eye Movements test, a Visual Acuity test, a Peripheral Optotype Identification test, the Nelson-Denny Reading Test, and Weschler Memory Scale subtests. *T*-test analyses revealed that only the color light group attained significant post therapy test results. Statistical gains in their post Nelson-Denny Comprehension ($p<.009$), Comprehension Reading Rate ($p<.009$), Vocabulary Reading Rate ($p<.049$) and Weschler Memory Scale, Logical Memory ($p<.035$) scores were documented. It was concluded that color light appears to hold promising therapy benefits for individuals with learning disabilities.

A large number of college students with learning disabilities are confronted with visual processing problems, reading comprehension and retention difficulties. Problems such as a poor reading rate, short attention span when reading, early visual eye fatigue, blurring of printed materials, skipping and/or re-reading of lines, headaches, and poor recall of materials studied often pose significant challenges to adults seeking to meet the high reading demands of college curriculums. Unfortunately, standard optometric exams and educational tests generally do not identify the specific types of visual symptoms many students with learning disabilities state they experience. While remedial programs have successfully enhanced many students' basic reading and study skills, visual processing difficulties often continue to persist.

When students' reading disabilities can be diagnosed through college assessment batteries, accommodations such as tutorial support, extended time on exams, access to recorded textbooks and private readers may be provided. Though these measures are appropriate academic adjustments, they do not directly alleviate students' visual symptoms nor the excessive time they require to compensate for their reading difficulties. Viable ways to remediate students' visual focussing, visual tracking and reading problems require further research. Some of the more commonly known therapies for working with students' visually based reading problems include vision training and the use of colored lenses or colored overlays while reading. Another little known avenue for addressing students' visual difficulties and reading problems involves the use of color light. In 1989 the investigator was presented an opportunity to evaluate the effects of color light therapy with adults in California State University, Sacramento's (CSUS) Learning

Disability Program. The present study was designed to assess alternative approaches to remediating students with learning disabilities' vision, reading, and retention problems.

A review of previous color light research revealed that as early as the 1920's and 1930's an ocular branch of science called syntonics (a therapy involving color light stimulation of the ocular system) was developed by researchers seeking to address visual problems that directly interfered with their clients' visual performance, behavior and academic skills. Research by Eames (1936, 1938) indicated that children with educational disabilities had constricted visual fields and that visual field constrictions could significantly limit the speed of one's visual perception. These results considerably influenced the use of syntonic treatment with reading disabilities and visual disorders.

Kaplan's (1983) syntonic study supported Eame's earlier research findings which indicated children with reading disabilities experienced significant reductions in their visual fields. In his study, Kaplan evaluated the effects of color light, white light, and vision therapy upon 22 children with reading disabilities. His research showed that the children receiving syntonic therapy significantly increased their visual fields 39.2% and 43.9% in the right and left eyes respectively. The children receiving vision therapy demonstrated overall visual field gains of 8.7%, and the children receiving white light therapy exhibited a 47.6% reduction in their visual fields.

A syntonic study Liberman (1986) conducted assessed 36 students ages 8-29 with academic underachievement primarily in the area of reading. His study compared the effects of a group of students receiving syntonic therapy with a

control group receiving no therapy. Results of his color light study indicated that the syntonic group increased their visual fields 87 times more than the control group did.

In addition to gains in students' visual fields, Liberman's study suggested that the syntonic therapy positively affected subjects' visual-verbal memory, visual-motor memory, and auditory-verbal memory skills. In particular, significant gains in visual memory were documented for the group receiving color light therapy. It was also suggested that the syntonic therapy positively affected students' tension levels and emotional states. As a result of the color light therapy, participants stated they could handle criticism and confrontations with greater ease. Following the color light treatments 75% of the syntonic participants reported improvements in their academic scores, 40% reported significant increases in their handwriting and two participants reported that they eliminated their daily use of Ritalin.

Downing (1989) additionally studied the effects of color light on children and adults with learning disabilities. His studies on color light were based upon a therapy and instrument (Lumatron) he developed subsequent to research in syntonics. Downing's ten years of case study results supported previous color light research findings. He reported that individuals with learning disabilities enhanced their visual fields, academic skills and emotional disposition with his Lumatron color light therapy.

Downing developed a training program so that individuals from varying fields of interest could use the Lumatron instrument in a therapeutic setting. Upon completion of Downing's certification training, the investigator (1989) conducted a pilot Lumatron study with college students in the CSUS Learning Disability

Program. The eight students who received color light therapy appeared to significantly benefit from their experiences. Within this initial study, posttest gains were observed in students' visual fields and in their Nelson-Denny Reading Comprehension and Nelson-Denny Reading Rate scores. Because many students within the pilot study stated that the Lumatron therapy had a relaxing effect upon them, it raised the question of whether relaxation therapy alone could produce similar test results. The present study consequently was designed to formally measure the effects of color light stimulation and the effects of taped relaxation exercises upon CSUS' adults with learning disabilities. The focus of the research was to determine if color light or relaxation exercise therapy could statistically effect students' vision, reading, or retention abilities.

Method

Subjects

All participants of this study were students certified to have a learning disability by Learning Disability Specialists at CSUS. In accordance with California State University criteria, students' cognitive eligibility scores were based upon Full Scale IQ (or other designated aptitude scores) utilizing the Woodcock Johnson Psycho-Educational Battery (WJPE) and/or the Weschler Adult Intelligence Scale-Revised. Students' achievement scores were based on exams such as th WJPE, Wide Range Achievement Tests-Revised, the Diagnostic Spelling Potential Test, the Lindamood Auditory Conceptualization test, and the Nelson-Denny Reading Test.

Students in the Learning Disability Program who reported or exhibited visual stress symptoms when reading such as blurring of letters, skipping/re-reading of

lines, early eye fatigue, a slower than normal reading rate and reading retention difficulties were asked to participate in the study. The 24 students who volunteered for the study indicated that they had experienced a long case history of learning difficulties. Due to schedule conflicts only 16 participants who began the study completed the research project.

The color light therapy group consisted of 5 females and 3 males. They ranged in age from 23-38 with a mean age of 31.3 years. Seventy-five percent of these participants were White and 25% of the participants were Hispanic. The Full Scale IQ scores of this group ranged from 79-100 with a mean IQ score of 90. The relaxation exercise therapy group consisted of 5 females and 3 males. They ranged in age from 24-48 with a mean age of 31.4 years. Fifty percent of these participants were White, 25% were Hispanic, 12.5% were Asian and 12.5% were Black. Full Scale IQ scores for this group ranged from 78-104 with a mean IQ score of 90.

All participants in the research study were undergraduate students who were not receiving concurrent visual or reading therapies. Due to the study's small sample size, students were not matched for gender, IQ, age or ethnicity. Instead, test scores were evaluated according to individual mean changes differences in pretest and posttest assessments.

Measures

The study's diagnostic test battery included reading, memory and vision evaluations. For the reading assessment, the Nelson-Denny Reading Test forms E and F were used. This test was comprised of two statistically equated forms which measured students' vocabulary and reading comprehension skills. The Nelson-

Denny Reading Vocabulary component assessed students' ability to read and define 100 vocabulary words. Answers to vocabulary questions were selected from a choice of five different word definitions. A total of 15 minutes was allotted for the Vocabulary assessment. The Comprehension component of the exam was comprised of eight literature passages with 36 questions to answer. Each question had a choice of five possible answers that best responded to the question. A total of 20 minutes was allocated for the reading comprehension component.

Norms for the Nelson-Denny Reading Test were based upon the college age population. In order to assess students' Reading Rate scores, the Nelson-Denny Comprehension and Vocabulary components were additionally evaluated in relationship to the number of questions participants attempted. The results of these non-standardized scores were then analyzed in conjunction with the number of exam questions students answered correctly.

The Weschler Memory Scale Forms I and II were utilized for the memory assessments. Three subtests of these statistically equated forms were administered. The first subtest given was the Logical Memory component. This subtest contained two story passages (four to five lines in length) that were read aloud to students. Immediately following each passage participants were requested to verbally recount the logical material presented. A maximum of 23 points were possible when the average number of ideas retained from both passages were scored. The second measure, Memory Span, assessed students' ability to auditorally recall numerical digits. The exam required students to recount forwards or backwards two trials of a series of three to eight digits. A maximum of 15 points were possible on this measure. The third subtest entitled Associate Learning required students to listen to

three trials of ten easy and hard associate word pairs. After the presentation of the word pairs only one of the two words was stated. Scoring was based upon students' ability to orally recall the correct associate word pair. A total of 23 points were possible in this evaluation. Norms for the Weschler Memory Scale Tests were based upon the adult population.

The vision tests administered in this study consisted of three evaluations. The Visual Acuity component measured students' distant and near point acuity according to standards established by the Modified Clinical Technique. In this exam participants were asked to orally read (with each eye independently) a chart with letters of varying sizes. Acuity scores were calculated according to the accuracy of the lines read in relationship to 20 feet of distance vision.

The second assessment, the Developmental Eye Movements (DEM) test, measured three patterns of saccadic eye movement integrity. In this exam, participants' horizontal, vertical and horizontal to vertical ratio eye movements were evaluated as they read lines of symbols across and down a page. Percentile rankings for this measure were based upon a random sample of 13 year olds (the oldest comparison group available for this assessment).

The third visual measure administered was the Peripheral Optotype Identification test. This visual measure assessed students' ability to simultaneously see (on a video display terminal) two letters presented at a central fixation point and to either the right or left of that fixation point. The test involved 120 trials of ten possible eccentricities (2.5, 5.0, 7.5, 10.0, 12.5) randomly presented for a period of 80 milliseconds. (The ten uppercase letters used in this study were the same ones used by researchers Geiger and Lettvin,1987.) Audio recordings of

movements were used to gauge the accuracy of student responses. The exam's final percentile analysis was based upon participants' correct responses with measurable fixation losses being excluded from the calculations.

Procedure

In Spring, 1991, the investigator assigned (via names randomly drawn from a list of volunteers) students to either a color light therapy or a relaxation exercise therapy group. Participants were told that the study was being conducted to assess their visual and learning skills and that their therapy may or may not benefit them. All participants in the study signed a consent form acknowledging their willingness to take part in the experimental research. Additionally they agreed not to discuss their therapy experiences with other students until the conclusion of the study. In order to reduce awareness about the research design, participants were not informed that two experimental groups concurrently existed.

In this study, each student was individually administered pre- and post-reading, memory and visual diagnostic assessments. Posttest scores assessed to be significant for any measure administered were evaluated then with *t*-tests. The Nelson-Denny Reading Test and the Weschler Memory Scale subtests were administered by the investigator and trained staff within the CSUS Learning Disability Program. The Visual Acuity, DEM and Peripheral Optotype Identification tests were administered by two graduate students in their final semester of University of California, Berkeley's Optometric Program.

In order for the investigator to determine light prescriptions, color light participants additionally received the Downing prescreening test measures: a phoria

11 test, evoked responses, and case history analysis. As a precautionary measure, these students were also screened to have a history clear of epilepsy and

test, evoked responses, and case history analysis. As a precautionary measure, these students were also screened to have a history clear of epilepsy and photosensitivity. Based upon Downing's methodology, each participant was prescribed two to three colors to be viewed within the red through violet color spectrum. Students determined to need an increase in energy stimulation were generally assigned spectral colors in the red-green range while students assessed to need a decrease in energy stimulus were prescribed colors in the blue-violet range. Each color was assigned a specific frequency speed (flash rate) for viewing the light according to Downing's specifications.

Color light therapy sessions entailed participants sitting alone in a quiet darkened room and viewing a color light emitted from the Lumatron instrument. In order to stimulate the optic nerve pathways to the brain, participants were positioned 18 inches away from the light and were instructed to focus on its source for a period of 20 minutes. Students within the color light therapy group were given their own folders and charts listing the specific color and flash rate they were to view each session. All students received individualized instructions on how to read and sign in on their charts, set a timer for twenty minutes, and operate the Lumatron instrument. Schedules of session times were provided to participants and make up times were offered to them when necessary. Color light participants received their therapy approximately three to four times a week until a total of 20 sessions were completed.

The relaxation exercise therapy sessions were based upon the conception of the investigator and her colleague Susan-Eiland Rickman. Taped relaxation exercises were chosen to closely match the requirements of the color light therapy sessions.

Eight relaxation exercises, approximately 20 minutes in length, were selected to expose students to a variety of stress reduction/relaxation techniques. Tape segments were taken from cassette recordings by Bearns and Dexter (1982), Konicov (1978), Miller and Halpern (1980), O'Hara (1990), and Wise (1988). The tapes encompassed regulated breathing techniques, muscle tension/release exercises, visualization experiences, self affirmations and music. Each selection was repeated two to three times to help reinforce the relaxation concepts.

The relaxation exercise therapy sessions consisted of a participant sitting alone listening (with headphones) to relaxation tapes from a cassette player. All students in the relaxation exercise therapy group were given their own folders and charts listing the tapes they were to listen to each session. The same sequence of tapes was prescribed for each participant. Each student received individualized instruction on how to read and sign in on their charts as well as how to operate the cassette player. Participants were given schedules of their session times and were provided make-up sessions when necessary. The relaxation exercise sessions were attended approximately three to four times a week until 20 sessions were completed.

Results

When the reading and memory evaluations were scored, it was determined that *t*-test analysis should be used with the Nelson-Denny Reading and the Weschler Memory-Logical Memory assessments. The *t*-test analysis of these measures indicated that the color light group experienced statistically significant gains on four post therapy variables. No statistically significant post therapy gains were observed

for the relaxation exercise group on any of these exams. The data obtained for these measures is summarized for both the color light group (Table 1) and the relaxation exercise group (Table 2).

Table 1

Color Light Group: Diagnostic Individual Mean Change Differences

	Pretest		Posttest		
	Mean	**SD**	**Mean**	**SD**	***t* value**
Nelson-Denny					
Comp.(1)	17.13	5.14	22.50	5.63	-3.56**
Comp.(2)	22.88	7.62	27.50	7.43	-3.61**
Vocab. (1)	51.75	14.11	55.75	14.27	-1.82
Vocab. (2)	65.50	18.49	73.25	17.82	-2.38*
Weschler Mem.					
Logical Mem.	9.63	2.12	12.19	2.10	-2.60*

Note: (1) Number of questions answered correctly; (2) number of questions attempted.

*p<.05. **p<.001

Table 2

Relaxation Exercise Group: Diagnostic Individual Mean Change Differences

	Pretest		Posttest		
	Mean	**SD**	**Mean**	**SD**	***t* value**
Nelson-Denny					
Comp. (1)	16.75	2.44	17.38	5.50	-.36
Comp. (2)	25.63	2.88	26.50	4.14	-.84
Vocab. (1)	46.63	13.58	50.00	16.34	-1.64
Vocab.(2)	68.50	17.79	71.63	20.50	-.84
Weschler Mem.					
Logical Mem.	10.19	4.42	10.31	2.70	-.10

Note: (1) Number of questions answered correctly; (2) number of questions attempted.

*p<.05. **p<.001.

Two variables within the Nelson-Denny Reading Comprehension exam were analyzed and found to be statistically significant for the color light group. Figure 1 reflects the individual pretest and posttest scores attained by the color light group on

the variable of Reading Comprehension questions answered correctly. Their individual mean change differences for this component were notably significant (p<.009). Figure 2 references the variable of pre- and post- Reading Comprehension questions attempted by the color light students within the 20-minute time limit. Again, significant individual mean change differences between the two exams were documented (p<.009).

Figure 1. Number of questions attempted by the color light participants on the Nelson-Denny Reading Comprehension test.

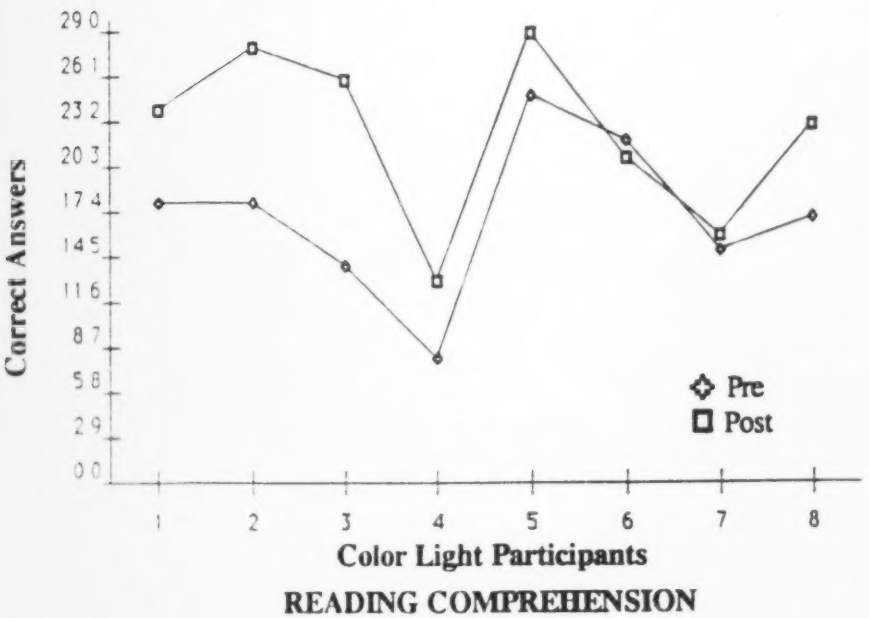
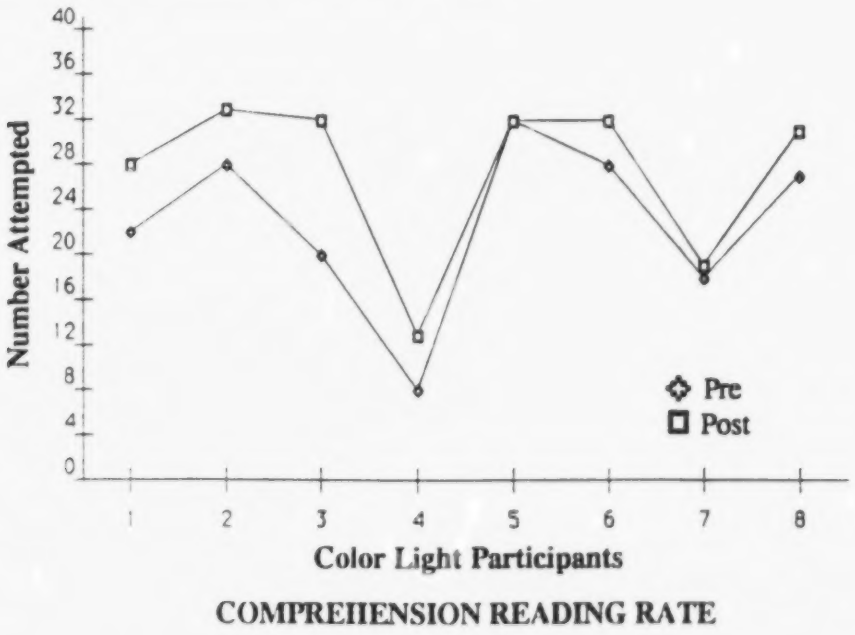


Figure 2. Number of correct answers attained by the color light participants on the Nelson-Denny Reading Comprehension test.



The color light participants' individual mean score differences on the Nelson-Denny Vocabulary component were also significant (p<.049). Figure 3 highlights the number of pre- and post- vocabulary questions participants attempted within the 15-minute time limit. Additionally, the color light group demonstrated significant individual mean change differences on the Logical Memory component of the Weschler Memory Scale (p<.035). Figure 4 shows the independent pretest and posttest correct answers attained by students on this variable.

Figure 3. Number of questions attempted by the color light participants on the Nelson-Denny Vocabulary test.

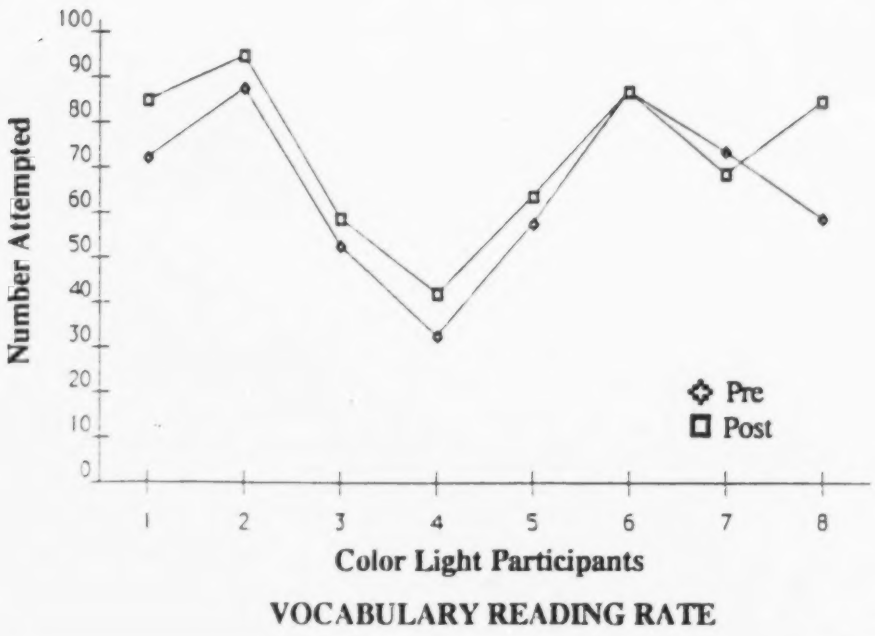
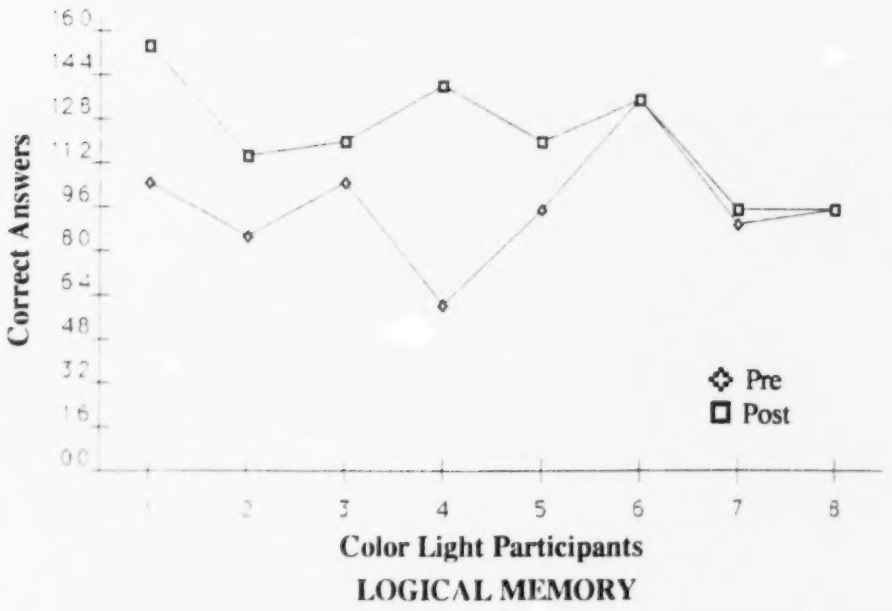


Figure 4. Number of correct answers attained by the color light participants on the Weschler Memory Scale, Logical Memory test.



Due to logistical problems, the sample size of the color light and relaxation exercise group was reduced to six people per group for the post therapy visual assessments. No statistically significant postvision results were observed for either the color light or relaxation therapy groups. Though the results were not statistically significant, it was observed that the color light group had a greater trend of increase than the relaxation exercise group did on their post- DEM and Peripheral Optotype Identification exams. It is also relevant to note that the Visual Acuity test

established that all participants in the study had at least 20/25 visual acuity skills (with the exception of one student who had 20/30 acuity in one eye).

Discussion

The results of this research study suggest that the color light therapy had statistically significant effects on C.S.U.S. students with learning disabilities in the areas of reading and memory skills. No statistically significant gains were observed for the relaxation exercise group in these academic areas. Additionally, no statistically significant gains were documented for either experimental group in the visual assessments administered.

Further analysis of this study's data and its diagnostic instruments reveal important research considerations. In regard to the study's visual assessments, the small sample size of the post data (six per group), made documentation of statistically significant effects from either experimental therapy highly unlikely. With strong acuity scores documented in pretesting measures, posttesting gains in acuity may not have been a realistic expectation of the study. The establishment of a minimum of 20/25 visual acuity in all students in the study (with the exception of the one student who had 20/30 visual acuity in one eye), did confirm that visually related reading problems can exist in spite of good acuity skills. This information is important for students with visual processing difficulties. Because standard optometric exams tend to focus upon individuals' visual acuity skills, students could benefit from an explanation of this evaluation's potential limitations. In the investigator's experience, students who are assessed with visual processing

measures (such as those provided by developmental optometrists) tend to receive more specific diagnoses of their visual problems.

Though the research results weren't statistically significant, the color light group showed greater trends of increase on the D.E.M. and Peripheral Optotype Identification exam than the relaxation exercise group did. Previous research studies have shown visual field expansion and blind spot reduction to occur with the use of color lights. Could increments in peripheral perception account for the statistical increases observed in the color light participants' Reading Rate scores? On both the Nelson-Denny Vocabulary and Comprehension tests, students exhibited statistically significant increases in the number of answers they attempted on the postexams.

Though the color light participants did not statistically increment their correct responses on the post- Nelson-Denny Vocabulary exam, it is speculated that these results were influenced by the test design. Because the level of vocabulary words increased in difficulty as the test progressed, it is possible that a faster reading pace would not be beneficial to students on this evaluation. In contrast to this data, the color light group statistically increased their number of correct responses on the post Nelson-Denny Comprehension test. The implications of these results are encouraging for they suggest that participants receiving color light therapy simultaneously benefitted from gains in reading comprehension and reading rate skills.

In addition to gains in reading scores, the color light group also experienced statistically significant increases on the Weschler Memory Scale's Logical Memory

subtest. These results supported Liberman's research findings which indicated that participants' auditory-verbal memory skills increased with the use of color light. The potential implications of this data are especially promising for individuals who listen to their books on tape. Because the ability to retain information is as relevant to students' learning skills as reading and comprehending materials, enhancement of auditory memory skills would be a valuable asset to them.

Due to the unavailability of statistically equivalent pre- and post- adult normed retention tests, this study limited its assessments to auditory memory evaluations. According to Liberman and Downing's research, a number of memory skills can be improved with color light therapy. If color light is indeed capable of enhancing a variety of retention skills, its advantages as a vision therapy would be uniquely different from color lens treatment and vision training exercises. Reading skill benefits in conjunction with retention skill benefits could make color light an optimal therapy for many students with learning disabilities.

At the onset of this research project it was speculated that students with learning disabilities might equally benefit from relaxation exercise therapy. Though the relaxation exercise group did not demonstrate statistical gains in this study's evaluations, both experimental groups responded quite favorably to their therapies. In fact, a majority of the study's participants requested to continue with their therapy sessions the following semester. When the research sessions concluded, participants within both experimental groups commented to the investigator that their therapies had a calming effect upon them. In the color light group, students receiving red or blue colors reported that the sessions helped them handle stress

more efficiently. These subjective responses lend support to prior studies suggesting that color light can enhance one's emotional state. In view of current research showing light to positively effect the emotions of people suffering from Seasonal Affective Disorder, this concept may have more validity than might first seem apparent. In future studies of this nature, formal evaluation of students' emotional dispositions is highly recommended.

Though a major limitation of this research project is the study's small sample size, the data does appear to substantiate other color light research findings. It is likely, however, that these research results will raise more questions than they will answer. For example, were the color light group's test results related to a placebo effect or posttest familiarity? If so, why weren't similar results observed within the relaxation group? What effects would a different design of relaxation exercise therapy have upon participants? Are the potential benefits of color light therapy sustained over time? And, can the statistical gains in reading rate, reading comprehension and logical memory observed in this CSUS study be replicated within the learning disability population at large? The answers to these and other relevant questions, can only be ascertained through additional research. It is hoped that this study will promote further investigations into color light therapy's ability to address students' visually based reading and retention difficulties. In seeking alternative approaches to remediating students' vision and academic skills, perhaps new solutions to old problems will be found.

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Carol J. Rustigan left her position as a Learning Disability Specialist at California State University, Sacramento in 1992 to establish a color light practice and to teach classes on whole brain learning.